

## View Point

# Learning to Live With Cheatgrass: Giving Up or a Necessary Paradigm Shift?

By Stanley G. Kitchen

### On the Ground

- The contemporary flora and fauna of North America represent the survivors of repeated waves of emigration through geologic time mixed with local evolutionary processes.
- The rate of intercontinental species exchange has increased exponentially during the last 500 years due to intentional and accidental transport by humans.
- Altered ecosystem composition, structure, and functionality are an inevitable consequence of species migration and naturalization.
- Highly successful newcomers, such as cheatgrass, should be viewed as permanent additions to North American flora.
- Researchers, land owners and managers, and policy makers would do well to acknowledge the new realities created by introduced species and focus efforts on 1) limiting new introductions, 2) assessing the variability of impacts across affected ecosystems, and 3) developing reasonable expectations and practices for mitigating effects while preserving core ecosystem functionality.

**Keywords:** cheatgrass, species migrations, invasives, Intermountain West, *Bromus tectorum*, ecosystem services.

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Natural ecosystems in the semiarid West face many stressors. Among the most challenging are those associated with invasive plant species. One invader that has had great impact over the last 100 years is the annual grass known as cheatgrass (*Bromus tectorum*). A few years ago, I made two observations that both confirmed and broadened my perception of this plant. In the first, I saw

it growing on sodden roofs in an historic community near the Mississippi River. I was reminded that the scientific name roughly means “brome grass that grows on roofs” and I gained insight into its long coexistence with humans. Later that day I observed a plant growing in the mud on the bank of the river. I pondered about what that place could possibly have in common with the vast shrublands of the semiarid West where cheatgrass has become so entrenched. Recently I found plants growing directly from the smallest of cracks in massive limestone slabs in the deserts of western Utah (Fig. 1). Reflexively I pondered, “Is there any place on earth cheatgrass cannot grow?”

*Bromus tectorum*, cheatgrass, downy brome, downy chess, early chess, drooping brome, June grass, bronco grass, 100-day grass, Mormon oats, military grass; each name reveals a distinct perspective of this North American immigrant. Before 1492, distribution included northern Africa, Europe and central Asia.<sup>1,2</sup> Cheatgrass expanded during the last 12,000 years in concert with the domestication and herding of livestock and with cultivated agriculture.<sup>2</sup> Cheatgrass was first observed in North America in Pennsylvania around 1790.<sup>1</sup> It is thought to have first arrived in contaminated grain or perhaps as packing material protecting a precious family heirloom.<sup>3</sup> The earliest record for the West was nearly 100 years later in 1883 from the state of Washington. By about 1930 it had spread to all 50 states (with the possible exception of Florida) and today its New World range includes all Canadian provinces, parts of northern Mexico, and temperate South America; even as its Old World range continues to expand.<sup>1</sup>

An early effort to synthesize existing knowledge regarding cheatgrass, its management, and its place on the North American continent occurred in 1965 at a gathering of experts in Vale, Oregon unpretentiously called, “Cheatgrass Symposium.” This gathering followed more than two decades of intensive research regarding the ecological and economic impacts of cheatgrass in the West. Papers of the proceedings capture the essence of the utilitarian tone that dictated rangeland values and an acknowledgement of the generally degraded condition of semiarid rangelands in this country at that time. Charles Poulton<sup>4</sup> wrote:



**Figure 1.** A cheatgrass plant growing from a crack in a large limestone slab in Millard County, Utah, USA. Picture was taken in June 2011. Photo courtesy of Stan Kitchen.

*In my opinion, one of the most critical moves in cheatgrass management... is the first decision one must make—namely, do I manage for continuation of the dominance of annuals or for the rapid or eventual return of perennials? Your answer to this question determines: (1) the management alternatives available to you, (2) the relative benefits you can expect, and (3) the risks and immediate or deferred costs you and the Nation may face as a result of your decision. (p. 9)*

Although a bit naïve, Poulton attempts to delineate a simple choice. He then suggests deeper insight into the long-term consequences of decisions regarding cheatgrass management; indeed, long-term consequences that were set in motion when the first itinerant seeds arrived. Fulcher<sup>5</sup> sounded fatalistic in his assessment of the permanency of cheatgrass in North American ecosystems, “We have for too long viewed cheatgrass as an undesirable invader that should be eradicated. We have not, as land managers, given enough consideration to the fact that cheatgrass is here to stay.” Having thus imposed a restricted view of the future potential of cheatgrass-infested rangelands, Fulcher followed with questions about cheatgrass management that were consistent with that view.

*Should we manage cheatgrass ranges for maximum cheatgrass production as an annual range type? Should we manage for the most effective utilization of cheatgrass but with a goal of a resulting upward trend in range condition toward a perennial range type? Is native perennial grass really more desirable than cheatgrass?<sup>5</sup> (p. 8)*

In the same proceedings W. A. Sawyer<sup>6</sup> wrote,

*Cheatgrass is an invader, a weed, an annual, a variable producer, a fire hazard, plus a host of other bad things that might be said about it. These may have influenced us to take a negative attitude about this grass [a gross understatement].*

*Perhaps we should consider this grass in a more positive way... The following dictates positive thinking.*

- 1) We have cheatgrass—several million acres—and we must live with it.*
- 2) The acreage is increasing, not decreasing.*
- 3) Cheatgrass is an effective soil stabilizer.*
- 4) Livestock production on cheatgrass is fair to good.*
- 5) From the standpoint of maintenance, management is less critical than it is for perennial grass.*
- 6) Cheat quickly increases in density, thereby decreasing invasion by less desirable species in wet years.*
- 7) Cheatgrass is a feed resource—in many places the only range feed available.*
- 8) Cheatgrass was a real blessing 20 to 50 years ago when range was going down in condition because of heavy use. (p. 11)*

I include these assertions not as statements of certainty but as expressions of viewpoints once held and that, though less widely, persist today. For those confident in the power of well-funded and well-focused science to produce solutions, there is temptation to dismiss such views as weakly veiled cover for continued ecosystem mismanagement. However, regardless of one’s perception, there is much to be gained in ascertaining to what degree these early researchers and managers were correct in their assessments and to consider the associated ramifications today.

Of course the pace of cheatgrass study accelerated and the focus broadened during the decades that followed that first cheatgrass symposium. Millions of dollars have been, and continue to be, dedicated to the study of the genetics, physiology, ecology, and pathology of cheatgrass, looking for some weakness to exploit that will provide a means for control. Exploring that body of work is not my purpose here, although such an exercise would clearly be informative. Instead I pose the simple question, *What makes cheatgrass so difficult to live with in North America that it justifies so great an effort to discover any means for control or eradication?*

Numerous answers to this question could be generated, invoking effects on fire regimes, biodiversity, successional trajectories, plant–herbivore interactions, resource cycling, etc. Each answer would be correct to some degree, reflecting a variety of perspectives. Similar lists might be generated for other broadly adapted invasive species. However, a single, all-inclusive reason for each may be as simple as the fact that they are not native. Of course that states the obvious. Therefore, I propose that any in-depth discussion about the challenges of cohabitating with this or any other biotic “foreigner” will benefit by a closer look at the concepts of what it means to be native or alien, and of migration and invasion.

### What Does it Mean to be Native?

In seventh grade biology we learn that purposeful movement is a basic attribute of life on earth. Even terrestrial plants, anchored in place, find ways to get around. With

that mobility, living things have always explored new neighborhoods. In light of that fluidity, it might be useful to define “native” as simply that attribute of having arrived first, or of having occupied a particular geography for the longest period of time. If there is any value in such a definition it will rely on a clear understanding of the appropriate spatial scales for application of the term. Although not universally acceptable, a widely used application, at least for land-based organisms, makes use of the natural boundaries offered by continental margins. Or put another way, species are native when they are found on the continent where they evolved or where they have become naturalized for some long period of geologic time. Conversely, an alien species is any that is not native. Migration occurs when propagules of a species disperse to and colonize a new place. Sometimes migrations cross continental boundaries. When that happens, a species is labeled alien as it takes up residence on a previously unoccupied continent. An invasion is a migration that is particularly successful, at least from the point of view of the invader. The migrant that is invasive is frequently viewed as a bit of a bad neighbor in its new home, disrupting the ecological status quo.<sup>1</sup> These definitions are simplistic but sufficient for making comparisons between contemporary, intercontinental biotic exchanges and those documented in the geological past.

Much of the earth’s surface has been occupied by expansive bodies of water for most of the 5 billion years of its existence. From the time of the evolution of land-dependent organisms, oceanic expanses have acted as barriers to migration. Geologic evidence supports the notion or theory of repeated aggregation and fragmentation of the continental plates.<sup>7</sup> Aggregations result in supercontinents. The most recent of these supercontinents we call Pangaea. Pangaea began forming in the Paleozoic Era and aggregation was apparently complete by the Permian Period (250–300 million years before present). The timing of Pangaea’s formation is not inconsequential. That is, Pangaea was unique in that it is the only supercontinent in the long history of the earth that has been occupied by complex terrestrial life forms and their ecosystems. All previous supercontinents formed before complex life forms had emerged from the primordial seas to occupy dry land. In contrast, by the time Pangaea began to split apart, dinosaurs and a highly diverse flora and fauna that together defined the various Mesozoic habitats occupied the entirety of the supercontinent.

So, ignoring islands that certainly existed in the Mesozoic seas, and allowing for the simplistic definitions stated above, it can be said that before the Pangaeian breakup, all terrestrial organisms were essentially native wherever they might have been found and that by default, there were no aliens. Although the importance of other factors that certainly impacted intracontinental species distributions and ecosystem assembly should not be minimized, it remains clear that there were few oceanic barriers to species migration at that time; a vastly different dynamic than what exists today.

By the end of the Mesozoic Era (65 million years before present), Pangaea had fragmented and the separate land masses were moving apart, though not to the full extent we see today. Terrestrial life continued to evolve but it did so in increasing isolation, resulting in escalating terrestrial biodiversity at a global scale.

All changed 65 million years ago when one or more large, extraterrestrial objects collided with the earth on what is now the Yucatan Peninsula in Central America. Whether due to shock waves, firestorms, megatsunamis, starvation, toxic gases, acid rain, rapid temperature drops, or combinations of these and other consequences of the impact, the earth witnessed one of its most rapid and severe extinction events and the dinosaurs, and a host of other animal and plant species, experienced local to global-scale extinction. Because of its proximity to the impact zone, North America was hit particularly hard; there life was transformed and for a time, vastly simplified.<sup>8</sup>

Subsequently, repeated pulses of plant and animal colonization from Eurasia, and more recently from South America, were made possible by variable sea levels and the formation and subsequent disappearance of land bridges as the continental plates continued to drift towards their current locations. And each colonization event brought a wave of new organisms, irreversibly disrupting established ecosystems. The fossil record reveals that deletions, or extinctions, of some so-called natives were a predictable by-product of each colonization event. If we could have witnessed any of these biological perturbations in compressed time we might have labeled these itinerant travelers as “invasive” and most certainly would have considered them alien. However, with time, ecosystems adjusted and the descendants of these immigrants became the “new” natives.

As a result, the fauna and flora present in North America today reflect a combination of the effects of repeated waves of colonization thoroughly mixed with local evolution through geologic time. Using the simple definition previously stated, it would appear that the attribute of “nativeness” has a distinct temporal dimension and that the accuracy of the label is dependent upon the temporal point of reference. For example, using a prehistoric context, extinct members of the horse and camel families that evolved here<sup>8</sup> are rightly classified as native, although closely related modern species from Eurasia are not. Similarly, with their long evolutionary history in North America, the case for numerous species of pine as natives is more easily made than that for sagebrush, a relative newcomer. Indeed ancestors of the iconic sagebrush crossed Beringia only a few million years ago,<sup>9</sup> making their widespread and highly successful descendants “less native” by extension.

### **How Does Knowledge of the Consequences of Past Species Migrations Inform Our Discussion About How We Should View Cheatgrass?**

Although similar in some respects to past colonization events, the rate of intercontinental emigration, and consequently eco-



logical change, today is exponentially higher than in the past due to intentional and unintentional intercontinental transport by the most traveled of all of earth's species, humankind. Cheatgrass is only one of a host of plant species to hitch a ride between the Eastern and Western Hemispheres during the last 500 years. In addition, genetic studies indicate that for cheatgrass, immigration to North America has happened multiple times and from different source populations.<sup>1</sup> In the book "1493: Uncovering the New World Columbus Created," Charles Mann<sup>10</sup> refers to this half millennium of accelerated species exchange as a "great unification." Jared Farmer<sup>11</sup> takes it a step further and calls it "a biotic recreation of Pangaea."

Although cheatgrass enjoys a broad North American distribution, it is clearly most successful in the semiarid West, and the Great Basin was, and remains, ground zero. Semiarid communities dominated by sagebrush are particularly well suited but pinyon-juniper woodlands and salt-desert shrublands have also provided good cheatgrass habitat. Cheatgrass is still on the move, occupying an increasingly larger land area across a broad geophysical and ecological spectrum.<sup>12</sup> While sagebrush, pinyon-juniper and salt-deserts remain the core ecosystems for cheatgrass dominance, its presence and importance is expanding into forest openings, montane shrublands, warm deserts, and southwestern grasslands. Future climate change is sure to keep the species on the move.

As with ancient colonization events, some rules of the game changed as this new player took to the field. For example, it is well known that the frequency and size of fires typically increase by an order of magnitude when cheatgrass occupies sagebrush communities due to the increased quantity and continuity of fine fuels, and to a longer fire season.<sup>13</sup> When cheatgrass invades, fire-sensitive species suffer and ecosystem processes are altered. Similarly, cheatgrass impacts on other ecosystem processes are often equally disruptive.<sup>2</sup>

Such changes are not unique to cheatgrass-infested landscapes, nor are they to North American species invasions.<sup>14,15</sup> Indeed, many ecosystems around the world are in tremendous flux as they absorb the impacts of nonnatives. Island ecosystems such as those found in the Galápagos, Hawaii, and New Zealand are particularly vulnerable. Examples of novel or hybrid ecosystems made from a mix of indigenous and immigrant species are many, and for the most part the changes have proven to be irreversible. Worldwide, these and other human-originating impacts are so great that serious consideration has been given to the declaration of a new geologic era, the Anthropocene. Some, including Charles Mann,<sup>10</sup> prefer an alternative title, "the Homogenocene," capturing the dual meaning of anthropogenic-induced change and biological homogenization made possible by creation of what might be viewed as a virtual Pangaea.

Many managers and researchers agree that it is time to accept this new reality and redirect efforts from restoring the lost past to better understanding the potential and limitations of the new present. This includes developing management strategies that allow for the preservation of ecosystem serv-

es in the context of novel ecosystems. For example, authors of the paper, "Top 40 Priorities for Science to Inform US Conservation and Management Policy,"<sup>16</sup> appear to understand the realities associated with species migrations. They state,

*The United States is experiencing rapid ecological and social change. Ongoing changes in land use, climate, nutrient cycles, and species distributions are geographically extensive and of considerable magnitude. These changes are creating new combinations of biological and physical conditions for which there exist no historical analogues on which to base predictions. (p. 290)*

### Is it Time to Acknowledge the Permanence of the Cheatgrass Invasion?

Today, few if any would argue that cheatgrass can be permanently removed from the North American ecosystems in which it has become deeply entrenched. The most we might hope for are conditions in which its impacts are reduced. In short, it is past time to accept cheatgrass for what it is, that is, just one of the most recent in a long history of plant migrants to this continent. And because it and numerous other aliens have successfully made themselves at home, recipient ecosystems will be forever changed. Management and research strategies of the future will need to more fully reflect acceptance of the permanence of many invasives, including cheatgrass. Specifically, the capacity to predict present cheatgrass distribution and future areas of expansion must be increased. Equally important is the need for ascertaining effects on ecosystem structure and processes across a wide range of biophysical settings. The impacts and threats of cheatgrass are not felt equally across ecosystems now, nor will they be in the future. To respond efficiently, managers will need to know how impacts vary in space and time and tailor management actions accordingly. In some settings it can be shown that cheatgrass is relatively benign, at least for the present, allowing resources to be channeled to higher priorities.

How important are invasive species issues in relation to other demands for environmental research? Of the 40 research priorities listed by Fleishman et al.,<sup>16</sup> three deal directly with challenges associated with species introduction. Framed as questions, these were:

- 1) *At what threshold values of abiotic or biotic attributes do ecosystems change abruptly in response to species extirpations or species introductions?*
- 2) *How will ecosystems be affected by the changes in species composition that are likely to result from changes in land use and climate?*
- 3) *How will changes in land use and climate affect factors that facilitate the spread of nonnative species?*

These and similar questions should provide the proper framework for resetting the focus for how we approach invasive species research and management issues in the future.

I return to Sawyer's<sup>6</sup> list of reasons to think positively about cheatgrass for a more critical evaluation. I suggest that he was correct in his assessment that we have "several million acres—and we must learn to live with it." His claim that "the acreage is increasing, not decreasing" also appears to be true. He asserted that "livestock production on cheatgrass is fair to good" and that "from the standpoint of maintenance, management is less critical than it is for perennial grass." Although largely true, these are not sufficient or appropriate reasons to manage for cheatgrass. I also note that there is ongoing interest in using livestock grazing to reduce cheatgrass biomass and thus reduce fire risk. Unfortunately, grazing intensities sufficient to accomplish meaningful cheatgrass reductions are generally damaging to remnant palatable perennials, ensuring cheatgrass dominance. In addition, cheatgrass production is highly variable from year to year and always ephemeral, the majority of growth occurring in a few short weeks after which it quickly loses forage value as it cures. Therein is found the origin of the common name, cheatgrass.

One of Sawyer's claims is that cheatgrass effectively excludes less desirable invasive plants. Anecdotal observations suggest that any exclusionary effect of cheatgrass on invasive plant species may be unstable and short-lived. There is clearly a need for additional research exploring the potential roles of cheatgrass to the exclusion or facilitation of other nonnatives.

Finally, we may identify circumstances, unrelated to livestock forage, in which cheatgrass could be viewed in a positive light. However, should that never happen it won't change the reality that, wherever cheatgrass is entrenched, any effort to understand or manage ecosystems will have to account for its presence. Knowledge regarding how it interacts within the full range of neighborhoods will better inform the still essential process of designing management strategies that effectively modulate the negative impacts. This principle is true for all invasive species, including many whose ecological impacts may be more severe than those imposed by cheatgrass. And because many invasive species occupy a broad range of habitats, we should expect that multiple management strategies and a full suite of tools will be needed.

We cannot rewind the clock. Whatever name is deemed most appropriate, the Anthropocene, Homogenocene, or some other conceptual construction, ecosystems of the world have been changed by a multitude of human-accelerated migrations. Consequently, we must deal with a host of species introductions, including that of cheatgrass, and the novel ecosystems they induce as permanent additions to earth's terrestrial landscapes.

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